MOTION SENSING APPLICATIONS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part application of co-pending U.S. Patent Application Serial No. 10/661,732, entitled "Remote Control Device Capable of Sensing Motion", filed September 12, 2003. Benefit of priority of the filing date of September 12, 2003 is hereby claimed for common material, and the disclosure of the U.S. Patent Application is hereby incorporated by reference.

BACKGROUND

The present disclosure generally relates to motion sensing applications, and more specifically, to using GPS-based motion sensing in such applications.

Typically, electronic motion sensing has been configured with a plurality of accelerometers and at least one gyroscope to provide translation motion readings on three axes, and roll, pitch, and yaw readings. This configuration can be used in various motion sensing

applications, including virtual reality applications and other interactive games.

Recently, several game developers (e.g., Sony Playstation) have been using built-in video cameras to optically capture and incorporate the motions of the player into the game. However, these motion sensing devices using accelerometers and gyroscopes, or video cameras can be cumbersome and expensive.

For example, to sense the motion of a player in an interactive game, the motion sensing device should be placed or worn on the body of the player. However, motion sensing devices configured with gyroscopes and accelerometers can be relatively heavy and bulky to be placed or worn on the body of the player. Further, motion sensing devices configured with built-in cameras are relatively expensive and require complex software to interpret the captured motions into useable digital signals.

SUMMARY

A motion sensing device provides visual display of motions to a user. In one aspect, the motion sensing

device includes sensors, display, and an interface device. At least first and second sensors are operatively configured to provide position information of at least first and second points, respectively, on the motion sensing device. The position information should be sufficiently accurate to distinguish the first point from the second point, such that the provided position information of the first point with respect to the position information of the second point provides enough information to determine motions of the motion sensing device with respect to a visual axis of the user. The interface device is coupled to the display and the sensors, and operates to transmit the motions of the motion sensing device to the display.

In another aspect, a gaming device includes sensors, display, and an interface device. At least first and second sensors are operatively configured to provide position information of at least first and second points, respectively. The position information should be sufficiently accurate to distinguish the first point from the second point, such that the provided position information of the first point with respect to the position

information of the second point provides enough information to determine motions of a user. The interface device is configured to couple the sensors to the user so that the motions of the user can be visually displayed on the display.

In a further aspect, a gaming method is disclosed. The gaming method includes providing at least first and second sensors to compute position information of at least first and second points, respectively. The position information should be sufficiently accurate to distinguish the first point from the second point, such that the computed position information of the first point with respect to the position information of the second point provides enough information to determine motions of a user. The gaming method also includes coupling the sensors to the user so that the motions of the user can be visually displayed.

BRIEF DESCRIPTION OF THE DRAWINGS

Different aspects of the disclosure will be described in reference to the accompanying drawings.

Figure 1 shows a motion sensing device according to an embodiment of the present invention.

Figure 2 is a block diagram of a motion sensing device according to an embodiment of the present invention.

Figure 3 illustrates a roll motion sensed by a motion sensing device in accordance with an embodiment of the present invention.

Figure 4A illustrates movement of a player's head on a screen in response to the roll motion of the motion sensing device according to an embodiment of the present invention.

Figure 4B through Figure 4D illustrate movements of an entire display in response to the roll motion of the motion sensing device.

Figure 5 illustrates a pitch motion sensed by a motion sensing device in accordance with an embodiment of the present invention.

Figure 6A illustrates visual displays for the pitch motion.

Figure 6B through Figure 6D illustrate movements of an entire display in response to the pitch motion of the motion sensing device.

Figure 7 illustrates a yaw motion sensed by a motion sensing device in accordance with an embodiment of the present invention.

Figure 8A illustrates visual displays for the yaw motion.

Figure 8B through Figure 8D illustrate movements of an entire display in response to the yaw motion of the motion sensing device.

Figure 9 illustrates a horizontal translation motion sensed by a motion sensing device in accordance with an embodiment of the present invention.

Figure 10A illustrates visual displays for the horizontal translation motion.

Figure 10B through Figure 10F illustrate movements of an entire display in response to the horizontal translation motion of the motion sensing device.

Figure 11 illustrates a vertical translation motion sensed by a motion sensing device in accordance with an embodiment of the present invention.

Figure 12A illustrates visual displays for the vertical translation motion.

Figure 12B through Figure 12D illustrate movements of an entire display in response to the vertical translation motion of the motion sensing device.

Figure 13A through Figure 13C illustrate different implementations of the motion sensing device in accordance with various embodiments.

Figure 14A through Figure 14D illustrate different placements of the motion sensing device within the player's body.

DETAILED DESCRIPTION

Various embodiments are described for a motion sensing device that can sense five degrees of freedom motions, which may include roll, pitch, and yaw directional motions, and horizontal and vertical translation motions. These motions can be illustrated on an electronic screen (e.g., a TV screen or a computer monitor) of a game or simulation as movements of an icon (e.g., an electronic depiction of a person) or as movements of an entire screen. The details of applications using the motion sensing device are described below.

Figure 1 shows a motion sensing device 100 according to an embodiment of the present invention. Figure 1 also illustrates a block diagram of an external device 120 and a screen 122 that interfaces with the external device. In one embodiment, the external device 120 is a computer. In another embodiment, the external device 120 is a television. In a further embodiment, the external device 120 includes any driver that can drive a display device to graphically illustrate the movement of the motion sensing device 100.

In the illustrated embodiment of Figure 1, the motion sensing device 100 includes an antenna 110 and a corresponding electronic circuitry, which are used to transmit or receive radio frequency signals to and from the external device 120.

In Figure 1, the motion sensing device 100 is configured as a headset to be worn on the player's head. The sensors 102, 104 of the device 100 sense the movement of the device 100 with respect to axis 106 or 108 (an axis that comes out of the page). In other implementations, a motion sensing device can be configured as any apparatus having a plurality of sensors that can sense the movement

of the device with respect to some axis fixedly related to the vision axis of the player. These other implementations are described in detail below.

The movement of the device 100 is measured in terms of movement of an axis (e.g., axis 106) linking the sensors 102, 104. Thus, in Figure 1, the movement of the axis 106 with respect to the axis 108 can be used to control and move a graphical icon, such as a person, or an entire image displayed on the screen 122. Details of various motions of the device are described below.

Various motions of the motion sensing device 100 are visually fed back to a user by the movement of the graphical icon displayed on the screen 122, or by the movement of the entire display shown on the screen 122. Movement of the icon or the entire display copies the motions of the motion sensing device 100. Thus, roll, pitch, yaw, horizontal translation, and vertical translation motions are combined and processed to produce a resultant movement of the icon or the entire display on the screen 122.

A block diagram of a motion sensing device 200 according to an embodiment of the present invention is

shown in Figure 2. The motion sensing device 200 comprises a main processor 202 and at least first and second sensors 220, which are operatively configured to provide position information of at least first and second positions, such as 112, 114 on the motion sensing device 100 of Figure 1. The position information provided by the sensors 220 should be sufficiently accurate to distinguish the first position (*e.g.*, position 112) from the second position (*e.g.*, position 114), such that the provided position information of the first position with respect to the second position provides enough information to the processor 202 to determine roll, pitch, yaw, horizontal and vertical translation motions of the motion sensing device.

The main processor 202 receives the position information of the first and second positions. The main processor 202 includes a motion converter 230 that processes the position information to determine angle and distance of the roll, pitch, yaw, horizontal and vertical translation motions. The processor 202 also includes a movement converter 232 which converts these motions into an amount of icon or display movement on the main screen. The main processor 202 interfaces with external devices (*e.g.*,

a computer 120 shown in Figure 1) through a transceiver 208 and an antenna 210. Thus, the amount of icon or display movement is transmitted to an external device through the transceiver 208. The transceiver 208 also receives commands and messages from the external device.

Figures 3, 5, 7, 9, and 11 illustrate various motions sensed by a motion sensing device in accordance with an embodiment of the present invention. In the illustrated embodiment of Figure 3, the motion sensing device 300 is shown in a configuration in which a device axis 306 (i.e., the axis that connects the two sensors 310, 312) makes a "roll" motion 302 with respect to the visual axis 308 (i.e., the axis that is coming out of the person's nose or eyes). Therefore, the "roll" motion 302 is defined in this specification as a counter-clockwise angular movement of the axis 306 linking the sensors 310 and 312 with respect to the visual axis 308.

As will be describe further below, the axis 306 can be calculated by precisely computing the positions of the sensors 310, 312 and taking the difference between the positions. By successively taking the differences as the

sensors 310, 312 move, the angular movement of the axis 306 with respect to the visual axis 308 can be calculated.

Figure 4A illustrates movement of a player's head 400 on a screen in response to the roll motion of the motion sensing device according to an embodiment of the present invention. Thus, when the player makes a roll motion 302 as shown in Figure 3, the player's head 400 in Figure 4A moves between directions B and D through direction C. In other embodiments, the roll motion of the motion sensing device can produce movement of different parts of the player or movement of icon other than the player, such as a directional arrow or cursor.

In further embodiments, Figure 4B through Figure 4D illustrate movement of an entire display in response to the roll motion of the motion sensing device. For example, visual display of Figure 4B corresponds to player vision in direction B, visual display of Figure 4C corresponds to player vision in direction C, and visual display of Figure 4D corresponds to player vision in direction D.

Figure 5 and Figures 6A through 6D illustrate visual displays for a "pitch" motion that correspond to Figure 3 and Figures 4A through 4D for the roll motion. Thus, in

Figure 5, the player's visual axis 500 makes a pitch motion 502, and the player's head 600 in Figure 6A moves up and down between directions B and D through direction C. Visual displays in Figures 6B through 6D show objects in different pitch angles, or elevations, corresponding to directions B through D in Figure 6A.

Figure 7 and Figures 8A through 8D illustrate visual displays for a "yaw" motion that correspond to Figure 3 and Figures 4A through 4D for the roll motion. Thus, in Figure 7, the player's visual axis 700 makes a yaw motion 702, and the player's head 800 in Figure 8A moves angularly sideways between directions B and D through direction C. Visual displays in Figures 8B through 8D show objects in different yaw angles corresponding to directions B through D in Figure 8A.

Figure 9 and Figures 10A through 10D illustrate visual displays for a horizontal translation motion that correspond to Figure 3 and Figures 4A through 4D for the roll motion. Figures 10E and 10F illustrate further movements with the horizontal translation plane. Thus, in Figure 9, the player's visual axis 900 makes a horizontal translation motion 902 or 904, and the player's head 1000

in Figure 10A moves forward and backward between directions B and D through direction C, or move laterally sideways between directions E and F through direction C. Visual displays in Figures 10B through 10F show objects in different horizontal positions corresponding to directions B through F in Figure 10A.

Figure 11 and Figures 12A through 12D illustrate visual displays for a vertical translation motion that correspond to Figure 3 and Figures 4A through 4D for the roll motion. Thus, in Figure 11, the player's visual axis 1100 makes a pitch motion 1102, and the player's head 1200 in Figure 12A vertically moves up and down between directions B and D through direction C. Visual displays in Figures 12B through 12D show objects in different vertical translation positions corresponding to directions B through D in Figure 12A.

Figures 13A through 13C illustrate different implementations of the motion sensing device in accordance with various embodiments. For example, Figure 13A illustrates the motion sensing device 1300 configured as a headset worn on the player's head. Figure 13B shows a similar configuration in which the sensors of the motion

sensing device 1302 are in communication wirelessly. Figure 13C shows another configuration in which the motion sensing device 1304 is configured as a pair of visual-display glasses.

Figures 14A through 14D illustrate different placements of the motion sensing device within the player's body. Thus, depending on a particular placement, the motion sensing device can be configured for different games or simulations. For example, Figure 14A shows the motion sensing device 1400 worn around the waist area of the player. Thus, in this configuration, the motion sensing device 1400 can be used in various dancing games or other games that sense waist movement.

In one embodiment, the device 1400 can be attached to the body of the user by a strap. In another embodiment, the device 1400 can be attached to the body of the user by an attachment element such as hook-and-loop devices.

The sensors of the device 1402 in Figure 14B are worn around the wrists of the player. Thus, in this configuration, the device 1402 can be used in a tennis game. The sensors of the device 1404 in Figure 14C are worn around the ankles of the player. Thus, in this

configuration, the device 1404 can be used in a soccer game. The sensors of the device 1406 in Figure 14D are configured as a combination of above-described configurations. Thus, this configuration can be used for games or simulations requiring motion inputs from multiple sources.

Various motions of the motion sensing device have been individually described above to illustrate the different possible movements of the player's visual axis. However, it should be understood that the processor 202, and in particular, the motion converter 230 processes these motions in combination to provide a resultant movement to the icon or the entire display for each instant in time. As described above, the movement converter 232 processes the resultant movement received from the motion converter 230 to generate motion parameters (e.g., a position vector and an angle) to move the icon or the entire display correspondingly. Further, it should be understood that the motion sensing device described above can be use to provide visual display of user's motions in a game or simulation.

All these are intended to be encompassed by the following claims.